

CLAIMS

What is claimed is:

1. A functionalized nanoparticle comprising:
  - a) a nanoparticle coated with a monolayer comprising a capture coating component;
  - b) a bifunctional protein having a first binding domain and a second binding domain, the first and second binding domains each comprising a member of a binding pair; wherein the bifunctional protein is affixed to the nanoparticle of (a) at the first binding domain.
2. A functionalized nanoparticle of Claim 1 wherein the nanoparticle is metallic.
3. A functionalized nanoparticle according to Claim 2 wherein the metal comprising the nanoparticle is selected from the group consisting of gold, silver, platinum, palladium, iridium, rhodium, osmium, iron, copper, cobalt, and alloys thereof.
4. A functionalized nanoparticle of Claim 1 wherein the nanoparticle is a semiconductor.
5. A functionalized nanoparticle according to Claim 4 wherein the semiconductor comprising the nanoparticle is selected from the group consisting of cadmium selenide, cadmium sulfide, silver sulfide, cadmium sulfide, zinc sulfide, zinc selenide, lead sulfide, gallium arsenide, silicon, tin oxide, iron oxide, and indium phosphide.
6. A functionalized nanoparticle according to Claim 1 wherein said monolayer is selected from the group consisting of:
  - a) molecules having reactive groups selected from the group consisting of:  $-NH_2$ ,  $-COOH$ ,  $-CHO$ ,  $-OH$ ,  $-X$  (Cl, Br, I), succinimide, and epoxy groups; and
  - b) biomolecules selected from the group consisting of: peptides; tiopronin and GSH.
7. A functionalized nanoparticle according to Claim 1 wherein said monolayer further comprises a shielding component.
8. A functionalized nanoparticle according to Claim 7 wherein the shielding component is selected from the group consisting of: short chain ethylene glycol oligomers, ethylene glycol methacrylate, sugars, crown ethers, and acrylamide.

9. A functionalized nanoparticle according to Claim 1 wherein said first binding domain comprises a member of a binding pair selected from the group consisting of: Glutathione-S-transferase/glutathione, 6X Histidine Tag/Ni-NTA, Streptavidin/biotin, S-protein/S-peptide,  
5 Cutinase/phosphonate inhibitor, antigen/antibody, hapten/anti-hapten, folic acid/folate binding protein, and protein A or G/immunoglobulins.

10. A functionalized nanoparticle according to Claim 1 wherein said second binding domain is a nucleic acid binding amino acid sequence.

11. A functionalized nanoparticle according to Claim 10 wherein  
10 said nucleic acid binding amino acid sequence is selected from the group consisting of DNA binding domains, and RNA binding domains.

12. A functionalized nanoparticle according to Claim 11 wherein said nucleic acid binding amino acid sequence is described by the citations selected from the group consisting of: Genbank accession  
15 number: NP\_417816, Genbank accession number: P03040, Genbank accession number: NP\_040628, Genbank accession number: NP\_059642, Genbank accession number: NP\_059641.

13. A functionalized nanoparticle according to Claim 10 wherein the nucleic acid binding amino acid sequence is a DNA binding zinc finger  
20 sequence.

14. A functionalized nanoparticle according to Claim 13 wherein the zinc finger sequence binds to a target sequence selected from the group consisting of SEQ ID NO:1, SEQ ID NO:2 and SEQ ID NO:3

15. A functionalized nanoparticle according to Claim 1 wherein said  
25 second binding domain has affinity for capture moieties selected from the group consisting of nucleic acids, peptides, biological cells, and inorganic nanotubes

16. A functionalized nanoparticle according to Claim 15 wherein the second binding domain of the bifunctional peptide has affinity for a carbon  
30 nanotube.

17. A functionalized nanoparticle according to Claim 16 wherein the bifunctional peptide comprises an amino acid sequence having carbon nanotube binding affinity selected from the group consisting of SEQ ID NO's 4-27.

35 18. A method for capturing a capture moiety comprising contacting a capture moiety selected from the group consisting of nucleic acids,

peptides, biological cells, and inorganic nanotubes with the functionalized nanoparticle of Claim 1.

19. A method according to Claim 18 wherein the functionalized nanoparticle comprises:

- 5           a) a nanoparticle coated with a monolayer comprising a capture coating component;
- b) a bifunctional protein having a first binding domain and a second binding domain, the first binding domain comprising a member of a binding pair, the second
- 10           binding domain comprising a nucleic acid binding amino acid sequence;

wherein the bifunctional protein is affixed to the nanoparticle of (a) through the first binding domain.

20. A method according to Claim 19 wherein the capture moiety is a nucleic acid.

21. A method according to Claim 19 wherein the nucleic acid binding amino acid sequence is a DNA binding zinc finger sequence.

22. A method according to Claim 19 wherein the zinc finger sequence binds to a target sequence selected from the group consisting of SEQ ID NO:1, SEQ ID NO:2 and SEQ ID NO:3.

23. A nucleic acid nanoparticle complex comprising:

- a) a nanoparticle coated with a monolayer comprising a capture coating component;
- 25           b) a bifunctional protein having a first binding domain and a second binding domain, the first binding domain comprising a member of a binding pair, the second binding domain comprising a nucleic acid binding amino acid sequence;

wherein the bifunctional protein is affixed to the nanoparticle of (a) through the first binding domain and is affixed to a nucleic acid fragment at nucleic acid binding amino acid sequence.

24. A nucleic acid nanoparticle complex according to Claim 23 wherein the nucleic acid fragment is immobilized on a solid support.

25. A nucleic acid nanoparticle complex according to Claim 23 wherein the nucleic acid binding amino acid sequence is a zinc finger.

26. A process for immobilizing a multiplicity of nanoparticles on a nucleic acid matrix comprising:

- a) providing a multiplicity of functionalized nanoparticles, each comprising:
- 5           i) a nanoparticle coated with a monolayer comprising a capture coating component;
- ii) a bifunctional protein having a first binding domain and a second binding domain, the first binding domain comprising a member of a binding pair, the second binding domain comprising a nucleic acid binding amino acid sequence;
- 10           wherein the bifunctional protein is affixed to the metallic nanoparticle through the first binding domain and wherein the nucleic acid binding amino acid sequence of each second binding domain is unique;
- b) providing a nucleic acid matrix having peptide binding domains having affinity for the nucleic acid binding amino acid sequence of each second binding domain of each bifunctional peptide of (a);
- 15           c) contacting the functionalized nanoparticles of (a) with the nucleic acid matrix of (b) under conditions whereby the nucleic acid binding amino acid sequence of the
- 20           bifunctional peptide bind to peptide binding domains of the nucleic acid matrix of (b) to immobilize the nanoparticles.
27. A nanometer scale electronic device made by the process of Claim 26.
- 25           28. A nanometer scale electronic device of Claim 27 selected from the group consisting of an electronic heterojunction, an electronic interconnect and a nano-wire.
29. A functionalized carbon nanotube comprising:
- 30           a) a carbon nanotube; and
- b) a bifunctional protein having a first binding domain and a second binding domain, the first binding domain having affinity for a carbon nanotube and the second binding domain comprising a member of a binding pair;
- wherein the bifunctional protein is affixed to the carbon
- 35           nanotube of (a) through the first binding domain.

30. A functionalized carbon nanotube according to Claim 29 wherein said second binding domain is a nucleic acid binding amino acid sequence.

5 31. A functionalized nanoparticle according to Claim 30 wherein said nucleic acid binding amino acid sequence is selected from the group consisting of DNA binding domains, and RNA binding domains.

32. A functionalized nanoparticle according to Claim 31 wherein said nucleic acid binding amino acid sequence is described by the citations selected from the group consisting of Genbank accession  
10 number: NP\_417816, Genbank accession number: P03040, Genbank accession number: NP\_040628, Genbank accession number: NP\_059642, Genbank accession number: NP\_059641.

33. A functionalized carbon nanotube according to Claim 31 wherein the nucleic acid binding amino acid sequence is a DNA binding  
15 zinc finger sequence.

34. A functionalized carbon nanotube according to Claim 33 wherein the zinc finger sequence binds to a target sequence selected from the group consisting of SEQ ID NO:1, SEQ ID NO:2 and SEQ ID NO:3.